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February 12, 1835.

WILLIAM THOMAS BRANDE, Esq., Vice-President, in the Chair.

Mr. Davies's paper, entitled "Geometrical Researches concerning Terrestrial Magnetism," was resumed and concluded.

The object of this paper is to exhibit methods of conducting the mathematical inquiries which are applicable to the magnetism of the earth, by the aid of the coordinate geometry of three dimensions.

When a point on the surface of the earth is given by means of its geographical coordinates, we can also refer it to any rectilinear coordinates that may be found convenient, and the transformations of the expressions can be made by known and familiar methods. Also, since at a given point the needle is deflected a measured quantity from the meridian plane, estimated on a tangent plane to the earth at the given point, and is also depressed another measured quantity below the same plane at that given point, its position is fixed by means of these measures. It will hence become capable of reference also to the same rectilinear coordinates as those into which the geographical coordinates were transformed. The equation of the line, into which the dipping-needle disposes itself, becomes, therefore, capable of expression in terms of the measured quantities above referred to; viz., the latitude, longitude, dip, and variation. The method of obtaining the constants which enter into the "equations of the needle" as referred to the equator, a given meridian, and the meridian at right angles to it, are then detailed at length by the author; and these equations are calculated for six different places: Port Bowen, Boat Island, Chamisso Island, Valparaiso, Paris, and Paramatta.

With a view to bring the hypothesis of the duality of the centres of magnetic force to a test, the author proceeds to reason, that as a free needle subjected to the action of only two poles, will always dispose itself in the plane which passes through those poles and the centre of motion of the needle, the needle prolonged will always intersect the magnetic axis, or line which passes through the two poles. But when four straight lines are given in space, a fifth line (or rather two lines) can be so drawn as to intersect them all. If, therefore, we have the equations of four dipping-needles calculated from correct observations, we ought to be able to assign the equations of the two lines which rest upon them; one or other of which, in such case, will be the magnetic axis itself. This line ought to intersect every other needle; and hence the constants in its equations and the constants in the equations of any fifth needle ought to fulfill the algebraical test of intersection. The author has calculated the equations of the magnetic axis for the needles at Chamisso, Valparaiso, Paramatta, and Port Bowen, and made a comparison of it with the Paris needle. Instead of intersecting, the least distance between the said axis and needle is more than one 6th of the terrestrial radius; and hence, could the observations themselves be depended on, as being free from instrumental error and from local disturbances, the question of the duality of the centres of force would be at once settled in the negative; but, as the opinions of those philo-

sophers who are best acquainted with the dipping-needle are decidedly that the dipping-needle is not yet in such a condition as to induce implicit confidence in its indications, and as, moreover, the influence of geological and meteorological sources of disturbance are yet so far unappreciated as to enable us to correct the observations for them, the author hesitates to draw any positive conclusion from the results he has obtained. However, the results thus obtained, being the direct and legitimate deductive consequences of the observations, it is of course impossible by any other course of investigations which proceeds from the same data, to draw a conclusion more to be depended on than this. The process he considers to be mathematically correct, as well as complete, and practicable; the question, as far as this test is concerned, must remain open till satisfactory data can be obtained: and he proposes at the earliest period to resume the numerical discussion of such observations as he may be able to procure.

Mr. Davies remarks, that from the great labour of the calculations, he has been led to attempt a more brief method of examination by means of carefully executed geometrical constructions; employing for that purpose the descriptive geometry, which has the advantage of bringing all the work to depend on the intersection of the hyperbola and straight line, situated upon the same plane. The resulting magnetic axes of the few cases he has constructed, though very far from coinciding, are yet positive in the same general region of the figure; and therefore the probability that their want of coincidence arises from erroneous and uncorrected observation is increased, and the importance of a more extended and careful series of observations considerably augmented.

For the purpose of examining the general character of the magnetical phenomena which ought to result from the hypothesis of the duality of the poles, Mr. Davies proceeds to investigate the formulæ which express those phenomena. These are, the magnetic equator,—the points at which the needle should become vertical,—the lines of equal dip,—the Halleyan lines, or lines of equal variation,—the isodynamic lines of Hansten,—and the points at which the magnetic intensity, compared with the points immediately contiguous in all directions, is a maximum, or in other words, where the isodynamic lines are reduced to points. The first two of these only, are treated in the present paper; the remaining ones will be the subject of a future memoir shortly to be submitted to the Society.

The mathematical processes themselves scarcely admit of verbal description; but the results of the investigation are briefly these.

When the centres of force are situated within the sphere, there will be one only, or some even number of continuous lines on the surface of the earth, at any point of which the needle will be horizontal, according as the poles be of equal or unequal intensities. Whether the magnetic equator be determined with sufficient accuracy to assure us that there is but one such line, is a matter of considerable doubt; but if it should be admitted that it is, it offers a strong confirmation of the strict analogy between the terrestrial and all other magnets with

two poles, and thence an increasing confidence in all the other analogies conceived to exist between them.

The points at which the needle is vertical are given by means of two equations, one of the fifth and the other of the second degree, and hence altogether there are ten such points theoretically possible. How many of these may be simultaneously real the equations do not, in their literal form, seem capable of determining; but at all events they will, in all cases, be an even number, either 0, 2, 4, 6, 8, or 10. One having been determined, one other at least must exist in the actual circumstances of the terrestrial two-poled magnet. How many soever such simultaneous points there may be, they must all lie in the same plane; and hence, if the second point which must exist could be determined, then the great circle in the plane of which the axis of the magnet itself is situated would be determined; and thus another test would be afforded of the truth or error of the hypothesis itself. Mr. Davies suggests that as this plane will be symmetrical with respect to the phenomena taking place on each side of it, its position might be tentatively assigned from a series of observations of those phenomena, especially of the dip and intensity; the variation being for obvious geometrical reasons excluded.

Though the resulting formula does not, in its literal form, appear to be capable of decomposition into factors, yet from some considerations, chiefly analogical, Mr. Davies is led to hazard the conjecture that it is capable of such decomposition; but as this is uncertain, he builds no consequences upon it, but leaves those consequences which would flow from it, open till it shall be discovered whether they would be justified by the conjecture itself being proved to be correct.

A paper was also read, entitled, "On certain Peculiarities in the double Refraction, and Absorption of Light, exhibited in the Oxalate of Chromium and Potash." By Sir David Brewster, K.H., L.L.D., F.R.S.

The crystals of the oxalate of chromium and potash are, generally speaking, opaque; for at thicknesses not much greater than the 25th of an inch, they are absolutely impervious to the sun's rays, and their colour, seen by reflected light, is nearly black; but when powdered, they are green; and the colour of the smaller crystals, viewed either by reflected or by transmitted daylight, is blue. One of the most remarkable of the properties of this salt is the difference of colour in the two images formed by double refraction. At a certain small thickness, the least refracted image is bright blue, and the most refracted image bright green. The blue is found by analysis with the prism to contain an admixture of green, and the green an admixture of red; and by candlelight this red predominating over the green, gives the crystal a pink hue. At greater thicknesses the blue becomes purer and fainter, and the green passes into red; and at a certain thickness the least refracted blue image disappears altogether, and the most refracted image is alone seen. At still greater thicknesses this image also disappears, and absolute opacity ensues. When the crystal is exposed to polarized light, with its axis in the plane of polarization,